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Effects of Eutrophication on Fisheries

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ABSTRACT: While eutrophication is often discussed in light of its impact on contact recreation, aesthetic character, and the quality of a water for water supply, it can also have a marked impact on the fisheries resources of a waterbody. Qualitatively, aquatic plants serve as the foundation for higher trophic level development; aquatic macrophytes provide habitat. Excessive fertility can also, however, have adverse impacts on the quality and quantity of fish that can be supported in a waterbody. This paper presents a discussion of the qualitative impacts of eutrophication and eutrophication management approaches on fisheries. It also introduces an approach for estimating the fish yield that could be sustained in a waterbody, and the change in fish yield that would be expected to result from eutrophication management practices involving P load reduction. This approach, which is an adaptation of the statistical Vollenweider-OECD eutrophication models, is a statistical relationship between the Vollenweider-normalized P loading and wet-weight fish yield. The use of this model as a quantitative management tool in the evaluation of the impact of nutrient load manipulation on the expected yield of fish is discussed.

KEY WORDS: fisheries, eutrophication management, modeling, algae, nutrient control.

I. INTRODUCTION

The overall degree of eutrophication of a waterbody, i.e., the amounts and types of aquatic plants, has a significant impact on the fisheries resources of the waterbody. From a positive point of view, the greater the amount of planktonic algae, typically the greater the sustained fish yield; aquatic macrophytes provide nursery grounds for young fish. On the other hand, there are also negative impacts on the quality of fisheries resources associated with increasing levels of primary production. For a given waterbody, the degree of fertility is, in turn, controlled by the loadings of aquatic plant nutrients to the waterbody. This paper reviews the current state of knowledge on the impacts of eutrophication on fisheries resources and the implications of commonly considered eutrophication management practices for fisheries.

It is important to note at the outset that, while the detailed dynamics of any waterbody arecomplex, the work of Vollenweider,[1-3] the authors,[4-11] and others has demonstrated that there are some rather simple, fundamental quantitative, stoichiometric relationships between nutrient load and planktonic algal biomass in waterbodies that have universal applicability. These relationships do not purport to describe the details of the ecological interrelationships among trophic levels, nor is that their purpose. Because of their fundamental nature, the extensive data base upon which they were developed, and the extensive documentation of their applicability to a wide variety of types of waterbodies, they are extremely useful for water quality management; they have been demonstrated to provide reliable quantification between nutrient input, which is a characteristic that can be controlled, and planktonic algae-related characteristics. Such a quantification is needed in order to determine how much improvement in water quality or fisheries resources can be obtained for each of the potential management strategies before any are adopted. This paper introduces and focuses on an adaptation of the Vollenweider-OECD eutrophication modeling approach to fisheries resource evaluation and management.

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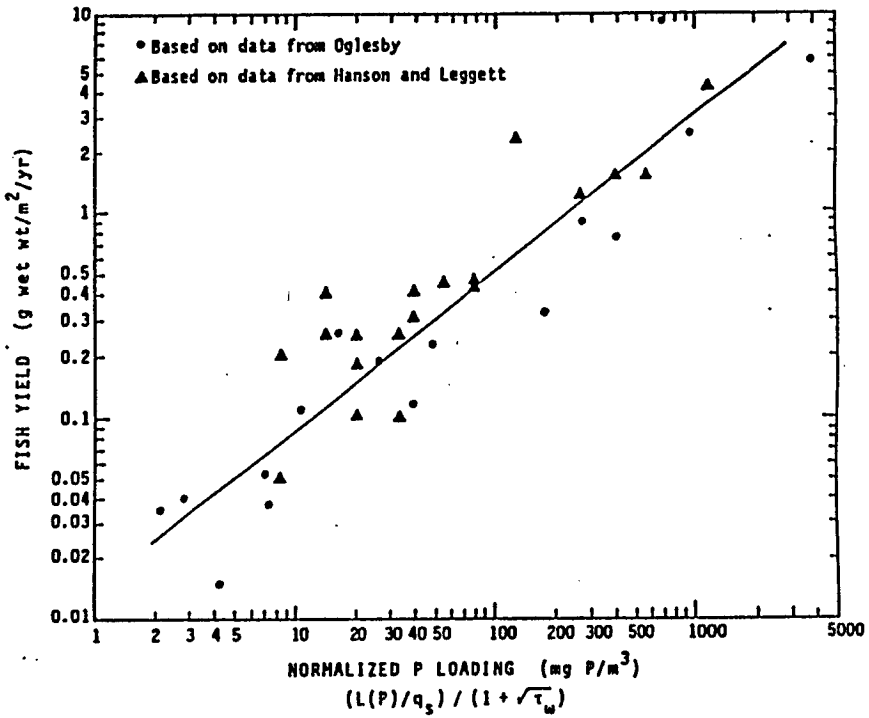
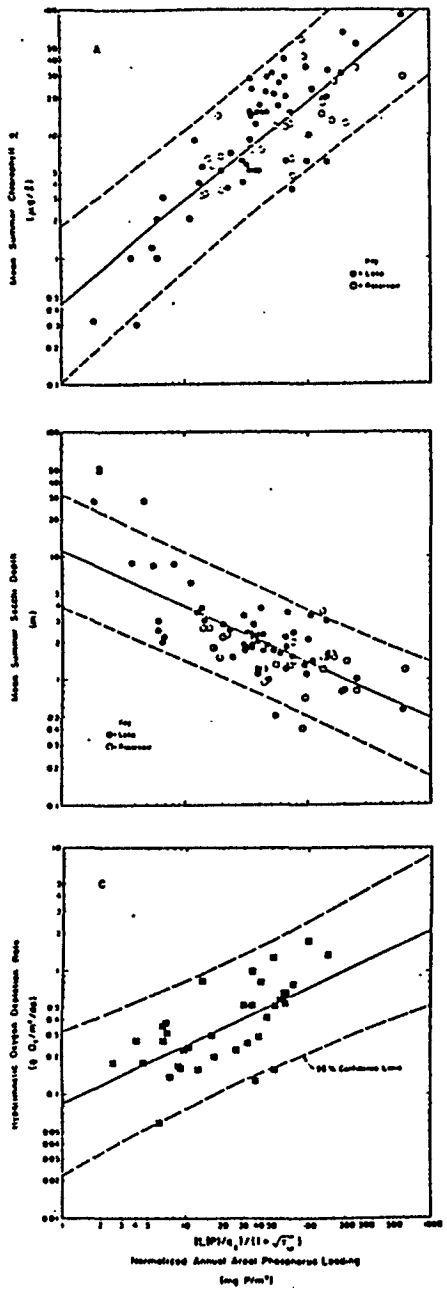
Relationship between Normalized P Loading and Fish Yield
(After Lee and Jones, 1981)





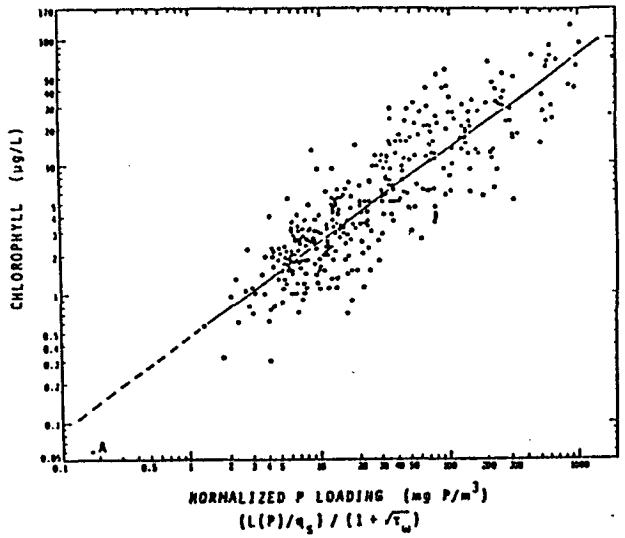
KEY

L(P) = Areal Annual Phosphorus Load (mg P/m²/yr)

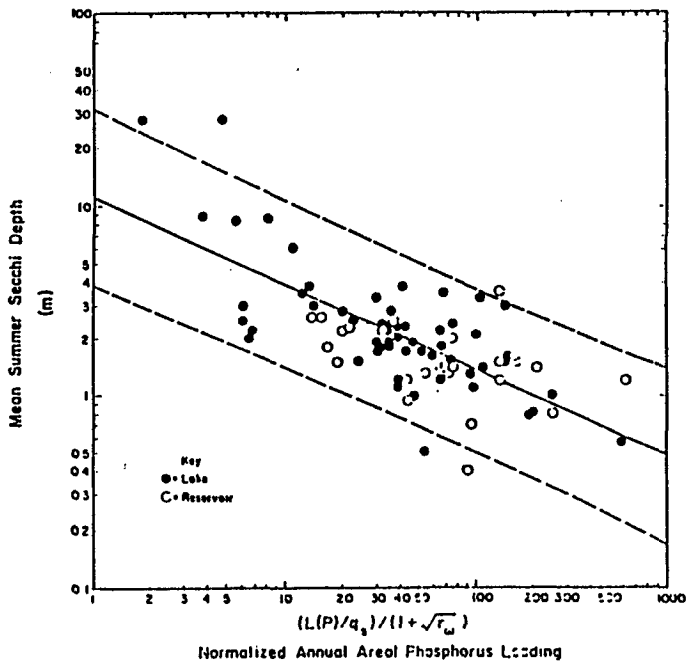
q_s = Mean Depth ÷ Hydraulic Residence Time = $\bar{z}/\tau_w$ (m/yr)

τ_w = Hydraulic Residence Time (yr)

Relationship between Normalized P Loading and Chlorophyll in Lakes & Reservoirs Worldwide



Relationship between Normalized P Loading and Water Clarity (Secchi Depth)



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